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An Unusual, Fangless Short-tailed Snake (Squamata, Serpentes, Homalopsidae) from Sumatra, Indonesia

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Abstract Two genera of fangless homalopsid snakes *Brachyorrhos* and *Calamophis* from eastern Indonesia have been described as basal members of the clade. A third genus belonging to this group from Sumatra, Indonesia is described here based upon morphology. Fangless homalopsid snakes share 19 dorsal scale rows at mid-body, fused dorsal scales above the cloaca, 5 to 7 upper labials, divided anal plate, divided subcaudals, 15–21 teeth on the dentary, frontal bone about 23% of skull length and other morphological characters that suggest they are related. All the three genera are known only from Indonesia. The new genus and species have a distinctive skull morphology with an absent premaxilla, a more depressed skull, and a larger eye than are present in *Brachyorrhos*.

Keywords *Brachyorrhos*, *Calamophis*, *Karnsophis*, basal homalopsids, skull osteology

1. Introduction

Homalopsids, long considered a subfamily of the Colubridae (Gyi, 1970), are a family of tropical Asian and Australopapuan snakes estimated to have originated ca. 53 mya (Pyron and Burbrink, 2012). Molecular work has supported the view that the clade is outside the Colubridae and that it forms the sister to most of the other colubroids (Kelly *et al*., 2003; Lawson *et al*., 2005; Vidal *et al*., 2007). Alternatively, Pyron *et al*. (2013) recovered a sister-group relationship between Homalopsidae and Elapidae + Lamprophiidae. The Homalopsidae (Gyi, 1970) share the following morphology: valvular, crescent-shaped nares; glottis fitting into internal nares; small dorsal eyes; rear grooved fangs on maxillary; tracheal lung; vertical pupils; hypapophyses throughout vertebral column; hemipenes divided for about one half of length, finely calyculate distally, cups shallow with blunt spines, sulcus forked, lobes with spines; shallow rostral notch; and downward projecting tongue (Smith, 1943; Gyi, 1970; Murphy, 2007). In addition, they share a viviparous reproductive mode and diets composed primarily of fish and crustaceans (Voris and Murphy, 2002; Murphy, 2007).

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The hypothesis that the short-tailed snake, *Brachyorrhos albus*, was a fangless homalopsid based upon its morphology was proposed by McDowell (1987). Using molecular techniques, Murphy *et al*. (2012a) confirmed the terrestrial, fangless, worm-eating *Brachyorrhos* was the most basal homalopsid. Further investigation revealed *Brachyorrhos* to be endemic to the Moluccas and composed of at least four species, as opposed to being monotypic (Murphy *et al*., 2012a).

Peters and Doria (1878) placed *Calamophis jobiensis* Meyer 1874, based upon a single specimen from Yapen Island, West Papua, in the synonymy of *Brachyorrhos.* Boulenger (1893) placed *B. jobiensis* in the synonymy of *B. albus*. Examination of museum material labeled *Brachyorrhos albus* and *B. jobiensis* from the Bird's Head region of West Papua suggested *Calamophis* is a valid genus containing three additional species (Murphy, 2012). The morphological similarity between the Moluccan short-tailed snakes (*Brachyorrhos* Kuhl in Schlegel, 1826) and the Bird's Head stout-tailed snakes (*Calamophis* Meyer) suggests that they are a clade of fangless homalopsids. Therefore, *Brachyorrhos* has at least four species restricted to the Moluccan Islands of eastern Indonesia and *Calamophis* contains four species (based upon six specimens) restricted to the Bird's Head region of western New Guinea and nearby the Yapen Island (Murphy *et al*., 2012a; Murphy, 2012). Figure 1 illustrates the distribution of the fangless homalopsid

clade.

Morphological characters suggesting *Brachyorrhos* and *Calamophis* form a clade include: rostral separating the nasal scales, 19 scale rows on the fore-body and at mid-body; short to very short, relatively thick tail; 5–7 upper labials (first labial smallest), prefrontal frequently fused with loreal and preocular; one pair of chin shields in contact with the first four lower labials; the fourth lower labial long; and relatively low number (9–16) of maxillary teeth. Literature suggesting the presence of *Brachyorrhos* on Sumatra include Bleeker (1857a, b; 1860) and Ludeking (1867). Dunn (1927) also suggested the genus was present in the Lesser Sundas. None of these references are supported with extant voucher specimens, although Bleeker (1860) reports localities of "(Pad., Agam.)" which presumably refer to the Prefectures of Padang and of Agam, Sumatra. In a review of the snakes of Sumatra, David and Vogel (1996) considered Bleeker's reports of the species to be erroneous.

2. Materials and Methods

2.1 Morphology We examined museum material related to *Brachyorrhos*. External morphological data were collected for 59 museum specimens (Murphy *et al.*, 2012a). Body and tail length measurements were taken to the nearest 1 mm. Ventral scales were counted following Dowling (1951). The terminal scute was not included in the number of subcaudals. Dorsal scale row counts were made about 10 ventrals behind the head, at mid-body, and about 10 ventrals anterior to the vent. Values for paired head scales (primary temporals, upper and lower labials) as well as maxillary teeth, and subcaudals are given in left/right order. Measurements of skull bones were taken using a combination of direct measurements from scans using the number of pixels, as well as proportional measurements from scans and photographs.

2.2 CT imagery For skull osteology, we used HRXCT studies of alcohol specimens (USNM 103578 and FMNH 142145) scanned at the HRXCT Facility at the University of Texas at Austin, USA. The resulting transverse data sets were digitally re-sliced along frontal and sagittal axes, and rendered in three dimensions using VoxBlast (Vaytek, Fairfield, IA). Winzipped grayscale tiff frames of 3 D rotations around two orthogonal axes and a 3 D cutaway along one axis (pitch, yaw, sagcut) were saved at original size. VGStudioMax settings were in .vgl and project files. QuickTime animations of 3 D rotations around two orthogonal axes (103579pitch.mov, 103579yaw.mov) and a 3 D cutaway along one axis (103579sagcut.mov) were compressed using QuickTime's JPEG 2000 compression (quality: medium).

3. Results

A single specimen (USNM 103578) from Sumatra collected in 1937 identified as *Brachyorrhos albus* was examined and found to be morphologically similar in scale counts, scale arrangements, color and pattern to *Brachyorrhos* from the Moluccan Islands (Table 1). However, the head of the Sumatran specimen is quite distinct from *Brachyorrhos*. It is depressed and narrow, the eye is large (greater than the eye-mouth distance), the snout extends over the lower jaw, and the lower jaw is somewhat countersunk (Figure 2). The Sumatran specimen also has a laterally compressed tail whereas the tails of most *Brachyorrhos* species tend to be cylindrical or show only a slight lateral compression.

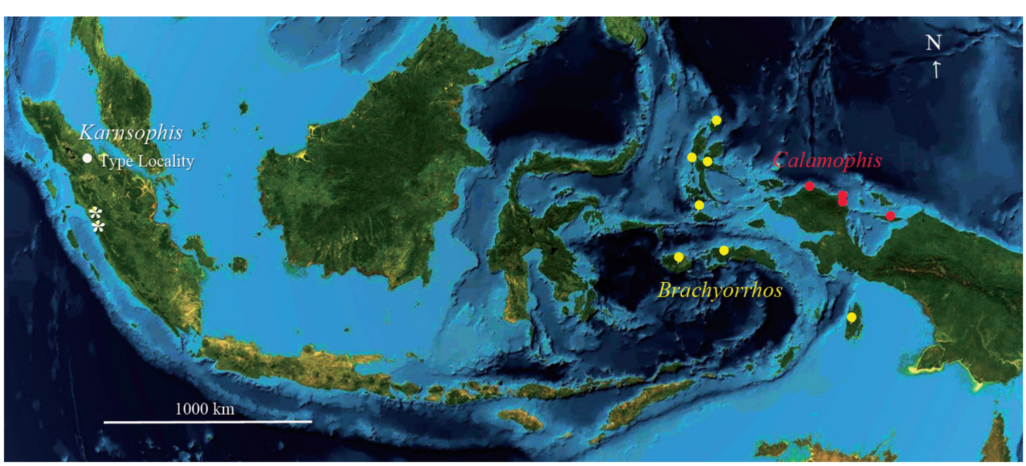

Figure 1 A map showing the type locality of *Karnsophis siantaris* and two other locations (asterisk) reported by Bleeker, 1860. Google Earth, Image @2012 TerraMetrics, @2012 Cnes/Spot Images, Data SIO, NOAA, US Navy, NGA, GEBCO.

CT scans of the skull of the Sumatran specimen and a *Brachyorrhos albus* from Ambon (FMNH 142145) were compared. A summary of some of the quantitative traits can be found in Table 2 and suggests that the two snakes are quite distinct in the snout region but similar in the more posterior portions of the skull (Figures 3–5). The most obvious differences are the absence of a premaxillary and the greatly reduced nasal bones in the Sumatran specimen.

***Karnsophis* new genus**

Brachyorrhos – Bleeker, 1857a: 472, 1857b: 231, 1860: 286; Ludeking, 1867: 50.

Distribution: Sumatra.

Diagnosis: A fangless homalopsid with 19 scale rows (not reduced posteriorly) distinguished from *Brachyorrhos* by depressed skull; rostral not visible from above; eye diameter greater than eye-mouth distance; countersunk lower jaw; and laterally compressed tail. Distinguished from *Calamophis* by 19 scale rows just anterior to vent (17 in *Calamophis*); divided internasal (single in *Calamophis*); divided nasal scale (single in *Calamophis*); and two postoculars (one in *Calamophis*). Premaxillary absent and nasal bones greatly reduced in size. Neural spine present on atlas (absent in *Brachyorrhos*).

Etymology: Named in honor of Daryl R. Karns for his contributions to homalopsid snake biology.

***Karnsophis siantaris* sp. nov.**

Brachyorrhos albus – Bleeker, 1857a: 472; 1860: 286; Ludeking, 1867: 50.

Holotype: USNM 103578, an adult male from Siantar, Sumatera Utara, Sumatra, Indonesia (~1º58' N, 99º47' E). The holotype was collected in 1937, the collector is unknown, but see discussion.

Distribution: Sumatra. Known only from the type locality. However, Bleeker (1860) reported Brachyorrhos albus from Agam (~0º15' S, 100º05' E) and Padang (~0º57' S 100º21' E) both central Sumatran locations (Figure 1).

Diagnosis: Rostral not visible from above (visible in *Brachyorrhos*), jaw slightly countersunk, upper jaw extending over lower jaw with anterior border mental posterior to posterior border internasal (in *Brachyorrhos* anterior edge of mental meeting anterior edge first labial and lower jaw not countersunk); eye diameter is greater

Table 1 A comparison of external morphological characters for three genera of fangless homalopsids. Abbreviations in columns are n = number; nd = no data; TL = tail length; * head width/head length.

Character	*Brachyorrhos*	*Calamophis*	*Karnsophis*
n	52	6	1
Distribution	Moluccas	Bird's Head, New Guinea	Sumatra
No. of species known	4+	4	1
Maximum SVL (mm)	660	320	415
TL/SVL males	7.4–14.6 (n = 17)	9.0–12.5 (n = 4)	12
TL/SVL females	7.9–11.3 (n = 10)	3.7–3.8 (n = 2)	nd
Eye diameter > eye-mouth distance	No (0.87)	No (0.90)	Yes (1.16)
Head depressed*	No (0.47)	No (0.43)	Yes (0.35)
Maxillary teeth	12–16	9–10	10
Head length /SVL	0.21	0.33	0.28
Head width/head length	0.86	0.84	0.66
Ventrals in males	158–190 (n = 17)	143–164 (n = 4)	166
Ventrals in females	171–195 (n = 10)	157–160 (n = 2)	nd
Tail laterally compressed	In some species	No	Yes
Rostral visible from above	Yes	Yes	No
Subcaudals in males	26–42 (n = 17)	10–23 (n = 2)	29/30
Subcaudals in females	18–29 (n = 10)	8–9 (n = 2)	nd
Posterior body scale rows	19	17	19
Dorsal scale shape	Ovate	Lanceolate	Ovate
Postocular (s)	2	1	2
Preocular	None or 1	1	1
Upper labials	5–7	5–6	7
Upper labials in orbit	3, 3 + 4, 4	3, 3 + 4, 4	4
Internasal	Divided	Single	Divided
Mid-ventral stripe	In two species	In all species	None
Fused dorsal scales over cloacal plate	Present	Present	Present
Tail shape	Tapered	Stout	Tapered
Tubercles in males near vent	Weak but present	Present	Present

Table 2 A comparison of skull morphology for three genera of fangless homalopsids. Each genus is represented by a single specimen. All skulls compared in the table are from males. The *Calamophis* specimen was not scanned and measurements are based on a photograph. Abbreviations in second column are used in Figures 3–5; Skull length = SL; Skull width = SW; n = number; nd = no data.

Skull characters	Abbreviation	*Brachyorrhos* FMNH 142145	*Calamophis* BPBM 3850	*Karnsophis* USNM 103578
Sex		Male	Male	Male
SL (mm)		23.1	10	19
SL/SVL (mm)		23.1/472 = 0.049	0.046	1.9/415 = 0.046
SW at widest point on parietals/SL (mm)		0.315	0.338	0.343
SW at narrowest point in orbit/SL (mm)		0.213	0.242	0.25
Basioccipital	bo	3 horns, Medial process very long	nd	3 horns, medial process about Same length as lateral processes
Basisphenoid	bs	Anterior end round	nd	Anterior end with 3 horns
Compound/SL	com	1.086	1.023	1.226
Dentary/SL	d	0.54	0.415	0.437
Dentary teeth		21/19 teeth	~16	15/17 teeth
Ectopterygoid/SL	ec	0.289	nd	0.198
Exoccipital/SL	ex	0.084	nd	0.063
Frontal/SL	f	0.229	0.238	0.237
Maxillary teeth	mx	21/19 teeth	nd	15/17 teeth
Maxillary length/SL		0.474	nd	0.437
Nasal length (mm)	na	4.7	~1.2	1.74
Nasal length/SL		0.205	0.119	0.091
Parietal length/SL	pa	0.38	0.451	0.45
Premaxilla	pmx	Present, no teeth Not attached to nasals	Present	Absent
Shape of prefrontal	prf	T-shape	Y-shape	T-shape
Prefrontal dorsal edge length/SL		0.155	nd	0.0391
Pterygoid teeth	pt	~45	nd	~30 teeth on each side
Quadrate length/SL	q	0.245	0.223	0.221
Neural spine on atlas		-	nd	+

than eye-mouth distance (in *Brachyorrhos* eye diameter equal to, or less than eye-mouth distance); primary temporal longer than supraocular (in *Brachyorrhos* temporal shorter than supraocular); nasal scale equal to the length of the first two labials (in *Brachyorrhos* nasal scale shorter, ca. 75% of the length of the first two labials); head depressed, ca. 35% of head length, (in *Brachyorrhos* head height ca. 65% of head width); tail laterally compressed, at mid-tail width ca. 72% of height (in *B. albus* tail width ca. 90% of the height at mid-tail).

Description of holotype: Male, 415 mm Snout-vent length (SVL), 50 mm tail length; head depressed, height ca. 35% of head length, and short, ca. 28% SVL; skull extending over lower jaw, forming beak-like appearance; anterior border internasal reaching posterior border mental; lower jaw slightly countersunk; rostral not visible from above, separating nasals, and broad as tall; nasal scale semi-divided into two lobes, nare in anterior lobe, posterior lobe inserted between upper labials and prefrontal-loreal shield, nare long, equal to the length of the first two labials; eye diameter greater (1.16×) than eye-mouth distance; two small internasals; prefrontals and loreals fused into large, domed shield; internasal seam and prefrontal seam equal, but prefrontal longer; frontal octagonal, longer than parietal seam; parietals long and tapered, extending posterior to rictus; preocular slightly undercutting orbit, contacted by upper labials 3 and 4; two postoculars, lower scale slightly smaller than upper one, and contacted by one temporal on right and two on left; upper labials 7/7, the first smallest, 2–3 contacting prefrontal-loreal shield, fourth in orbit, sixth tallest and longest; large occipital/paraparietal scales contacting temporal scales; primary temporal longer than supraocular, contacted by the sixth upper labial; lower labials 7/7, the first pair make contact on midline of chin posterior to mental, second pair small and barely visible from the side, the first four in contact with chin shields, the fourth largest and longest; single pair chin shields long (5.5 mm), and equal in length to frontal; gulars 5; dorsal scales smooth, in 19 rows; dorsal scales about 9 ventrals anterior to vent with one or two slightly elevated, light colored tubercles; broad and round ventrals 166; anal plate divided; subcaudal scales 29/30; tail laterally compressed; mid-tail width 72% of height; and tail length 12% of SVL.

Pattern and color in alcohol: Crown head dark brown,

Figure 2 A comparison of the profiles of members of the three genera of fangless homalopsids. A: *Karnsophis siantaris* from Sumatra; B: *Brachyorrhos raffrayi* from Ternate; C: *Calamophis ruuddelangi* from Western Papua.

upper labials slightly lighter in color, tip of chin slightly darker; most of chin uniform yellow-cream; dorsum uniform red brown, first two scale rows slightly lighter in color; ventrals uniform yellow-cream, mid-ventral stripe present on tail, subcaudal scales with dark pigment toward the mid line.

Diet: Stomach contains a very well digested frog with visible eggs and toes.

Etymology: This new species is named after the type locality, Siantar.

4. Discussion

The holotype was collected during the George Vanderbilt Sumatran Expedition in 1937. The field work was co-sponsored by the National Geographic Society and the Smithsonian. William M. Mann, Director of the National Zoological Park, headed the expedition. Extensive papers summarizing the expedition results for fishes, birds and mammals were published, but other specimens collected were not discussed in research reports, with exception of a three page paper on reptiles by Sackett (1940). The specimens described by Sackett were mostly collected near Meloewaki, Kutacane, Aceh, Sumatra. Unfortunately, this paper makes no mention of this specimen or the details of its collection.

While we have no reason to doubt the locality data associated with this specimen, the type locality is more than 3000 km from the Moluccas. The expedition was scheduled to visit the Moluccas (Anonymous, 1936), and the possibility of confusion over the collecting site cannot be completely ruled out.

Molecular and morphological data anchor *Brachyorrhos* within the Homalopsidae (Murphy *et al*., 2012b), and the shared morphology suggest that *Brachyorrhos*, *Calamophis* and *Karnsophis* form a clade of fangless homalopsids. The fangless clade contains species that are terrestrial, semi-aquatic, and aquatic (Murphy, 2012). These three basal genera fall within the current distribution of the Homalopsidae, although *Calamophis* is in West Papua and the adjacent Yapen Island may be interpreted as somewhat peripheral to homalopsid distribution.

Alfaro *et al*. (2008) suggested the crown (rear-fanged) homalopsids evolved about 21.8 MYA and that the three major clades they recovered evolved between 20–18 MYA. Murphy *et al*. (2012b) found a relatively short node distance between *Brachyorrhos* and the rear-fanged homalopsids, suggesting it likely evolved in the late Oligocene or early Miocene.

The two primary alternatives for the geographic origin of basal homalopsids, Asian vs. Australopapuan, remain unresolved. An Asian mainland origin is strongly supported by many present-day vertebrate distributions including the distributions of more advanced homalopsid genera such as *Cantoria*, *Cerberus* and *Fordonia* (Murphy, 2007; Alfaro *et al*., 2008). An Australopapuan origin for the fangless homalopsids is suggested by the eastern Indonesian distribution of *Brachyorrhos* and *Calamophis*.

Corvoid birds (Jønsson *et al*., 2011) and at least five other vertebrate lineages have distributions centered or restricted to the islands on the northern edge of the Australian plate and east of the Asian plate. These lineages potentially date to at least the Miocene (Oliver, 2011). They include an endemic radiation of ceratobatrachid frogs; two lineages of endemic blind snakes, *Acutotyphlops* and Pacific *Ramphotyphlops*; and two lineages of skinks, *Corucia* and the very ancient *Tribolonotus*. Oliver (2011) notes that the distribution of these lineages is generally centered to the north of

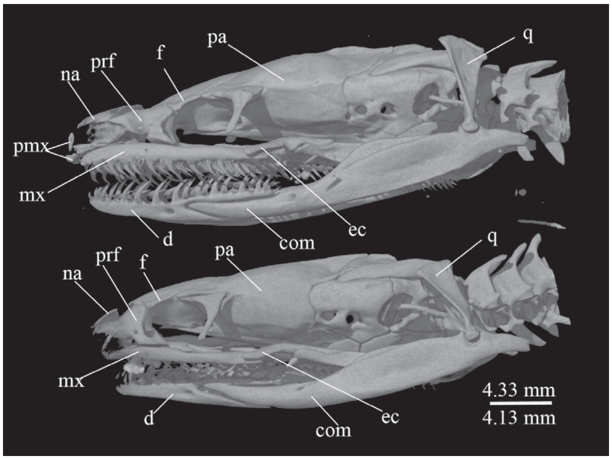

Figure 3 Profile scans of *Brachyorrhos albus* (FMNH142145) above and *Karnsophis* (USNM 103578) below. Explanation for abbreviations of bones can be found in Table 2.

Figure 4 Crown view scans of *Brachyorrhos albus* (FMNH142145) above and *Karnsophis* (USNM 103578) below. Abbreviations are explained in Table 2. Not listed in Table 2 is: su = supratemporal.

present-day New Guinea, and they are absent or relatively depauperate in New Guinea itself (although this is not true for *Calamophis* based upon current knowledge). He hypothesizes that a proto-Papuan archipelago to the north of the Australian plate and east of the Asian plate has a long history and has played an important role in persistence and dispersal of lineages since the Miocene or earlier. He adds that the distribution of additional skink, gecko, and bat lineages in this area suggests other clades may have a similar history. Fangless homalopsid snakes may be part of this relictual fauna.

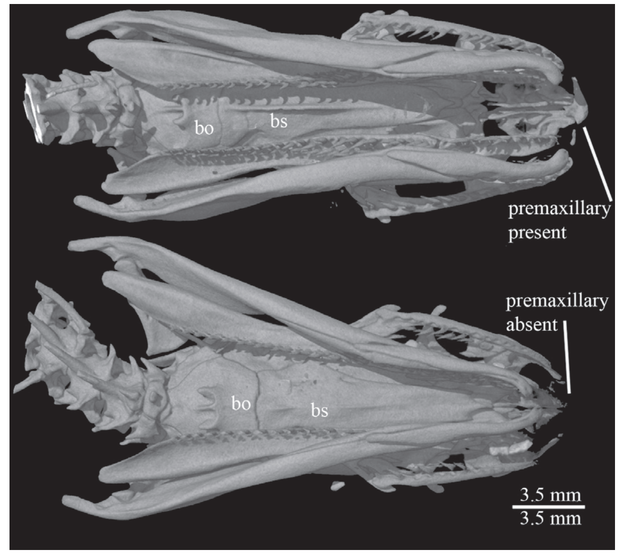

Figure 5 Ventral scans of *Brachyorrhos albus* (FMNH142145) above and *Karnsophis* (USNM 103578) below. Explanation for abbreviations of bones can be found in Table 2.

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